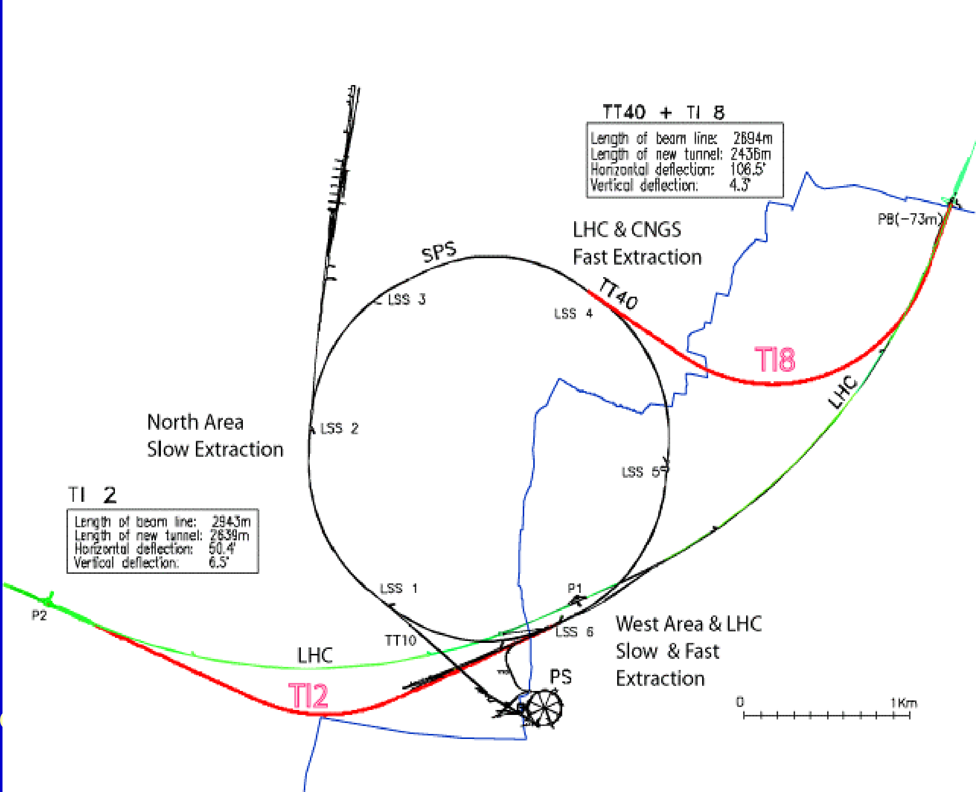
Upcoming Beam Tests

- **TT40**
  - 2 x 24 hours, September/October 2003
- **TI8**
  - 4 x 24 hours, September 2004
- **LHC Injection test (?)**
  - 2 weeks, April 2006
- **TI2 commissioning**
  - April 2007
- **LHC commissioning**
  - April onwards 2007



TI8 – test with beam

Extract beam to TED at end of TI8

- September – October 2004
  - (possibly Jeune Genevois to minimise impact)
- Length 4 x 24 hours
- Intensity
  - LHC pilot beam foreseen for the most part
  - Up to 2.5×10^{11} ppp allowed for

Objectives

- Verify equipment functionality:
  - Bumpers, Extraction Kickers, Extraction Septa, Magnetic elements, Power converters, Interlocks, control system, surveillance systems, vacuum
- Commission beam instrumentation
  - BPMs, BLMs, BCT, Screens, BST
- Beam measurement & correction
  - Trajectory acquisition and correction, check correction scheme
  - Reproducibility of trajectory
  - Matching from SPS
  - Optics in line, tilts, matching to LHC
  - Aperture
  - Check corrector and BPM polarities
- 12 hour run to validate thermal behaviour of tunnel
- Multi-bunch extraction
- Check RP assumptions
- Preparation for LHC injection test…

Requirements

- General services: cooling, power, ventilation, emergency stops, phones (required for system tests)
- Control system: infrastructure,fibres, networks, FEs, timing, application software, etc..
- Prior tests and preparation time (already from TT40 see that dry runs are essential)
- Special procedures: in & out of test mode
- Special interlocks: SPS intensity, beam loss, BPMs
- Beams: LHC pilot available 24/24
- Monitoring: already under development for TT40
- Radiation Protection:
  - Monitors outside zone, ventilation monitoring etc.
- Decommissioning procedures: to be defined
  - Radiation survey, removal of access gates etc

Impact

- **Status after test (residual activation)**
  - However TI8 already a Simple Controlled Area
- **Cost of test**
  - Powering: (96 x 36 MW x 30 CHF/MWh ~ 50 kCHF)
  - Temporary measures:
    - Access doors + cables + procedures, interlocks, extra beam stop (160x80x80 cm^3 of iron surrounded by 80 cm of concrete)
  - Decommissioning
  - 4 days out of the SPS physics schedule
- **Impact on other work**
  - LHCb access (yes with film badge + intensity interlocks)
  - Other installation (CNGS)
  - QRL commissioning: RA87, UA87 & closed part of 8-1
  - Magnet transport into 8-1
  - Installation 7-8

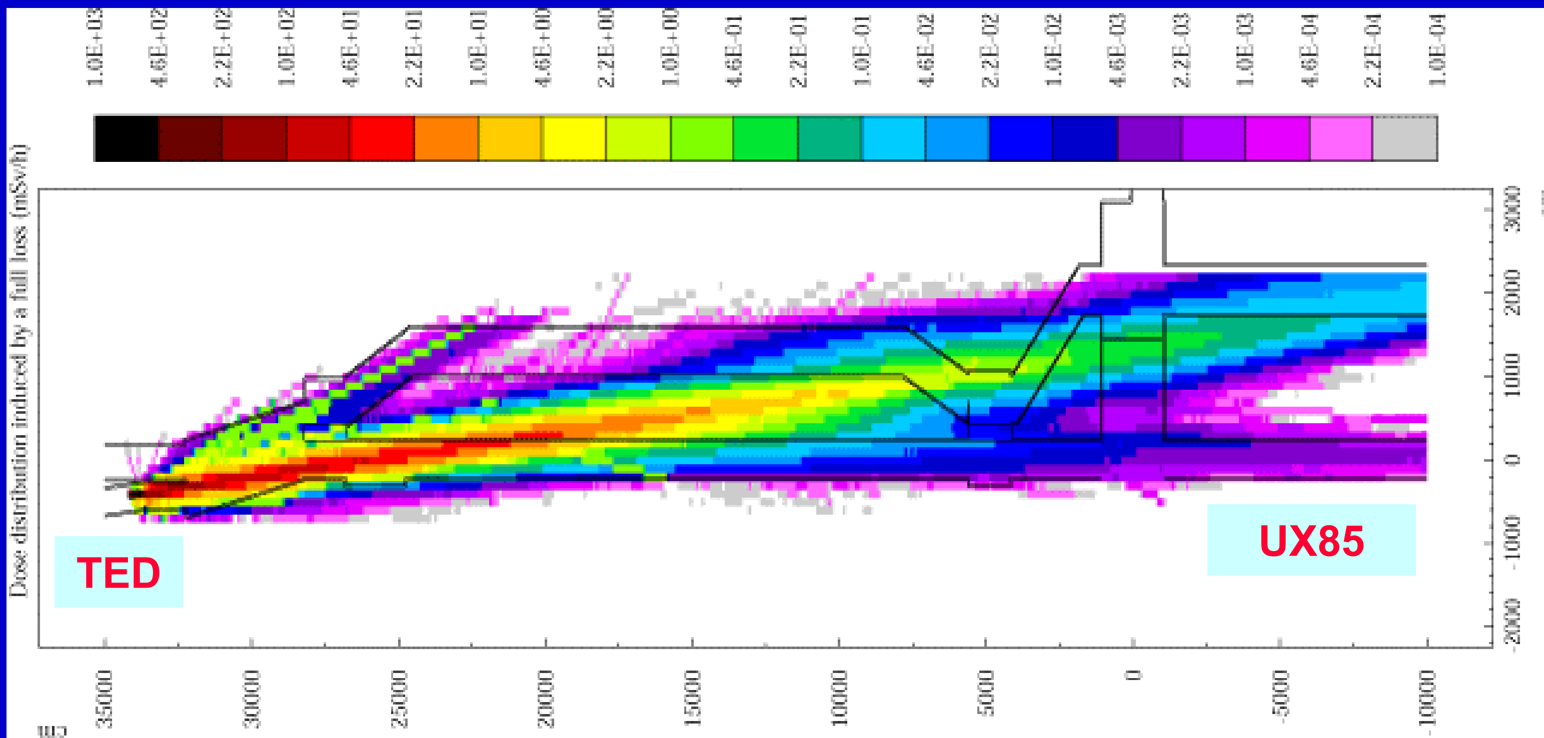
TI8

TI8

Radiation

Simulations have been performed by Radiation Protection Group

e.g. high energy muons…



Graham Stevenson et al

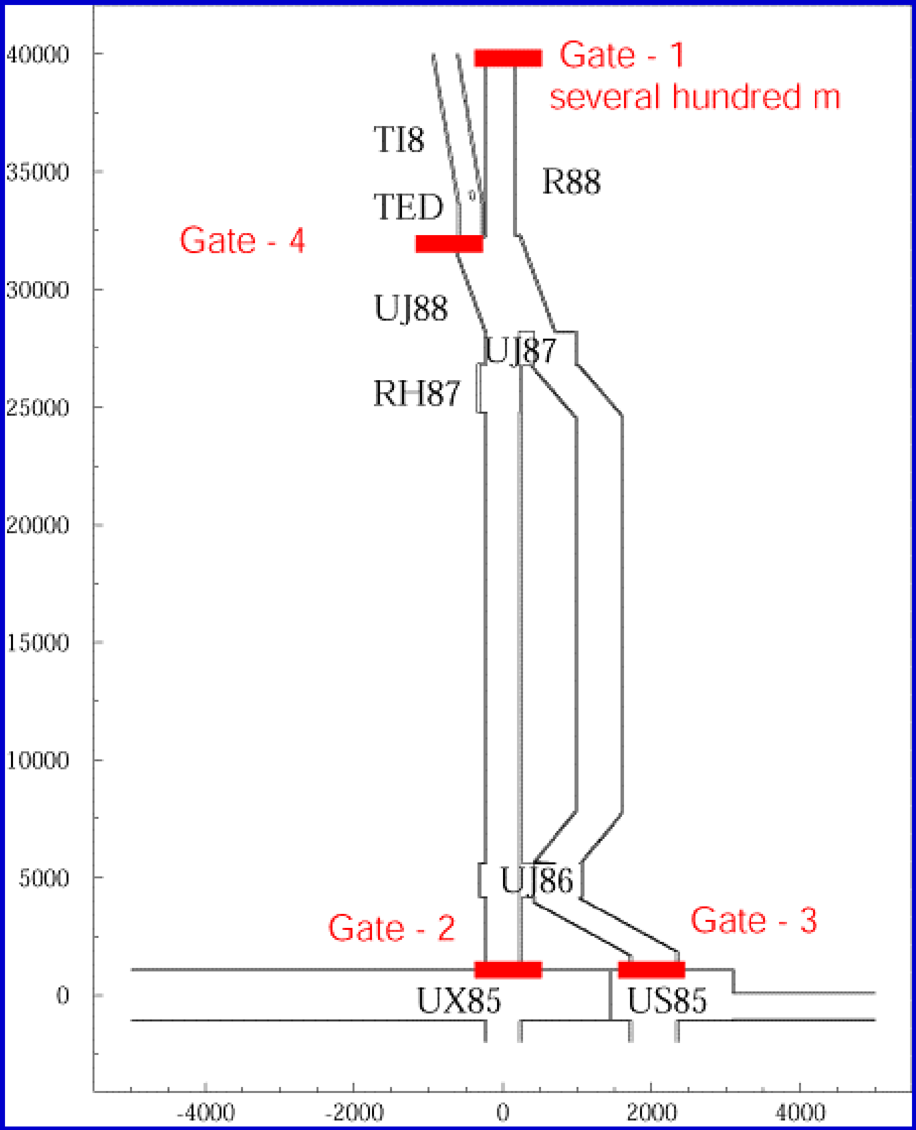
Radiation

- **Planned intensities:**
  - **Maximum assumed:**
    - 50% x 2.5 x 10^{11} ppp i.e. 5.4 x 10^{14} protons in 24 hours
- **Remnant dose rates (after one day irradiation & one day cooling)**
  - Along side TED: 120 μSv/h
  - Downstream face of TED: 3 mSv/h
  - Will have a extra beam stop (Iron/concrete) after the TED
  - Some irradiation of concrete walls around TED
- **UX85**
  - On Beam line 2.5 μSv/h

After test : area around TED → Simple Controlled Radiation Area

TI8

Access



- Temporary zone at end of TI8
- Gates interlocked: cables pulled back to SPS interlock system
- Gate 1 prevents access from Point 1
- Gate 2 prevents access from UX85
- Gate 3 prevents access from US85
- Gate 4 at UJ88 junction with TI8 – some form of separation since TED becomes Simple Controlled Area after tests.
- Radiation monitors required in R88, UX85 and US85.

TI8 conclusions

TI8

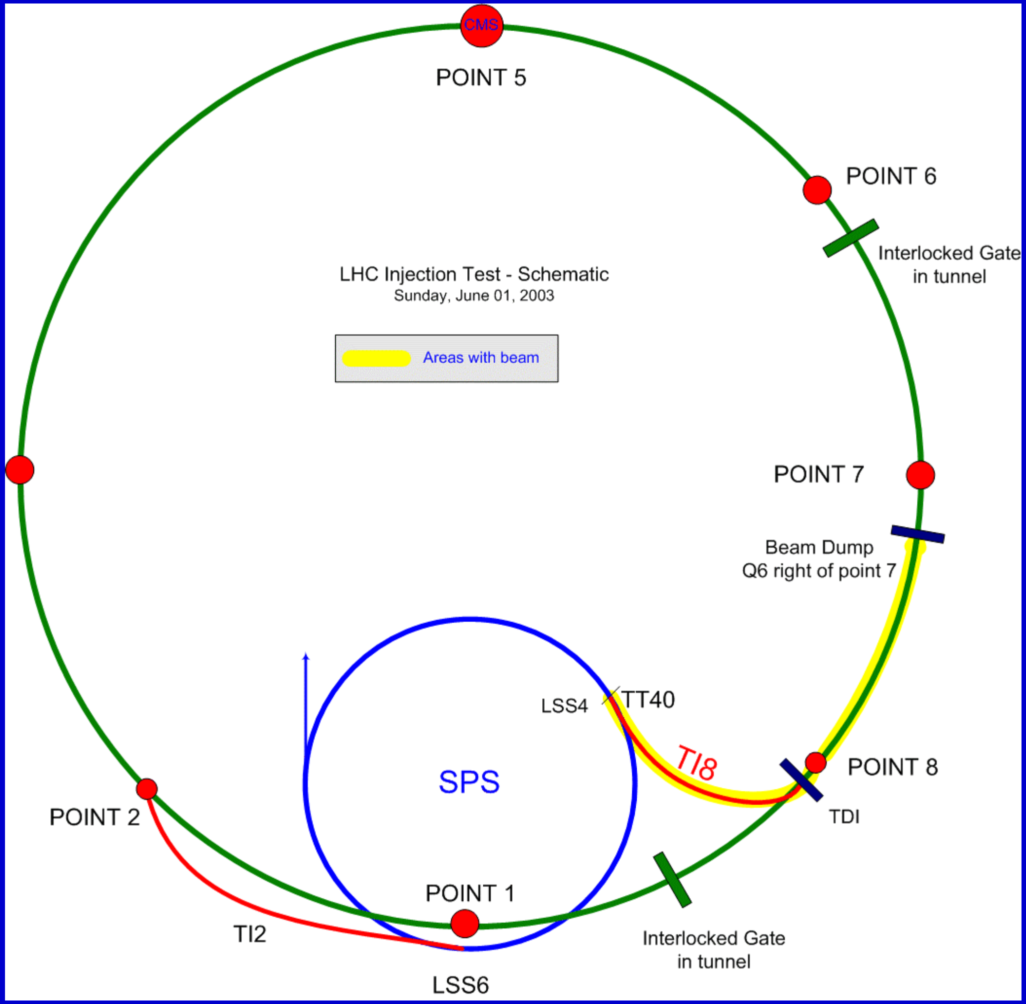
- 4 days with low intensity beams
- Cost and impact limited but…
- …careful planning and integration is required
- Provides important milestone on the path to LHC commissioning
  - Controls, Beam Instrumentation, Operations, Interlocks etc.
  - Usefully de-coupled from LHC commissioning
    - Resources, problem resolution and as a milestone

LHC Injection test 2006

- Outline
- Motivation
- Proposed tests
- Pre-requisites & boundary conditions
- Issues
  - Radiation / INB
  - Access
  - LHCb
- Impact
- Cost
- Conclusions

Injection test in 2006

The installation schedule version 1.7 recently approved includes a 'possible injection test' - foreseen in April 2006

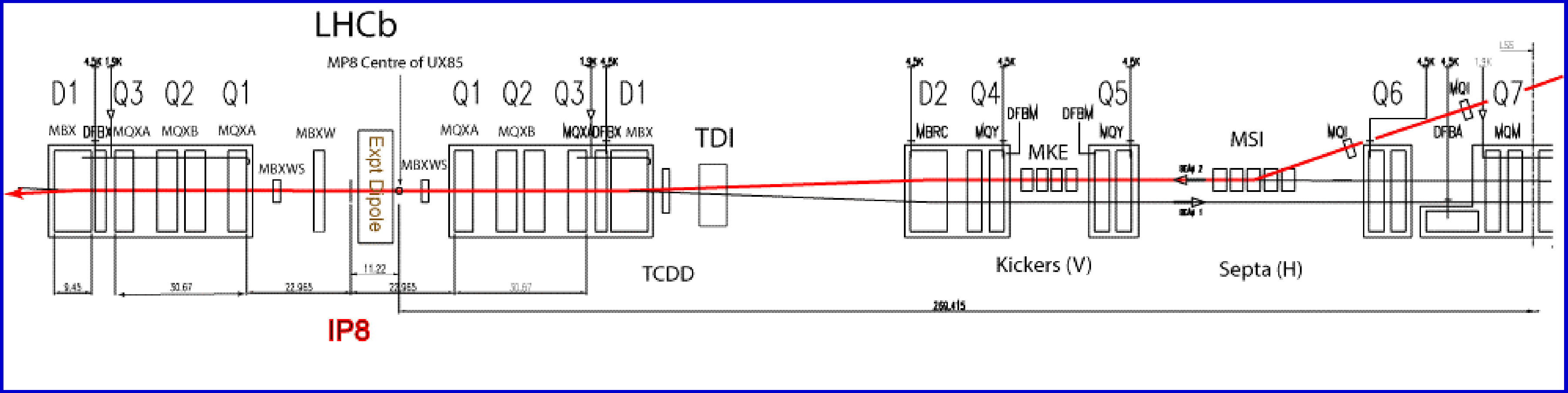


3.3 km of the LHC including one experiment insertion and a full arc

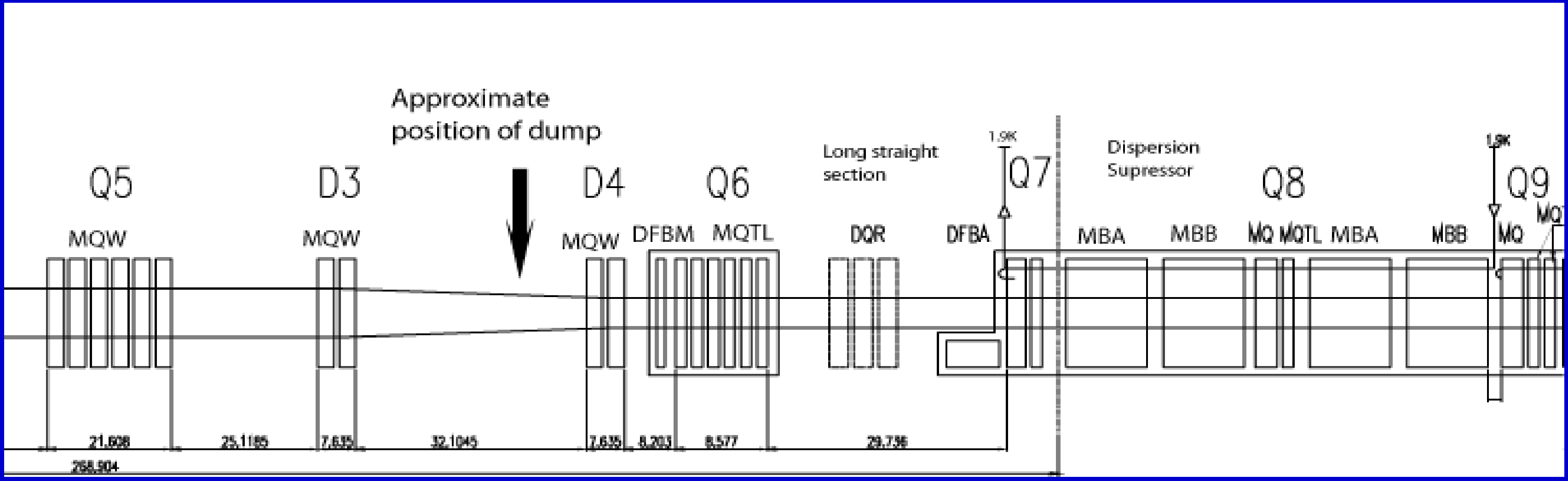
About 30 cells with a phase advance of ~ 3000 degrees total.

Layout

Point 8



Point 7

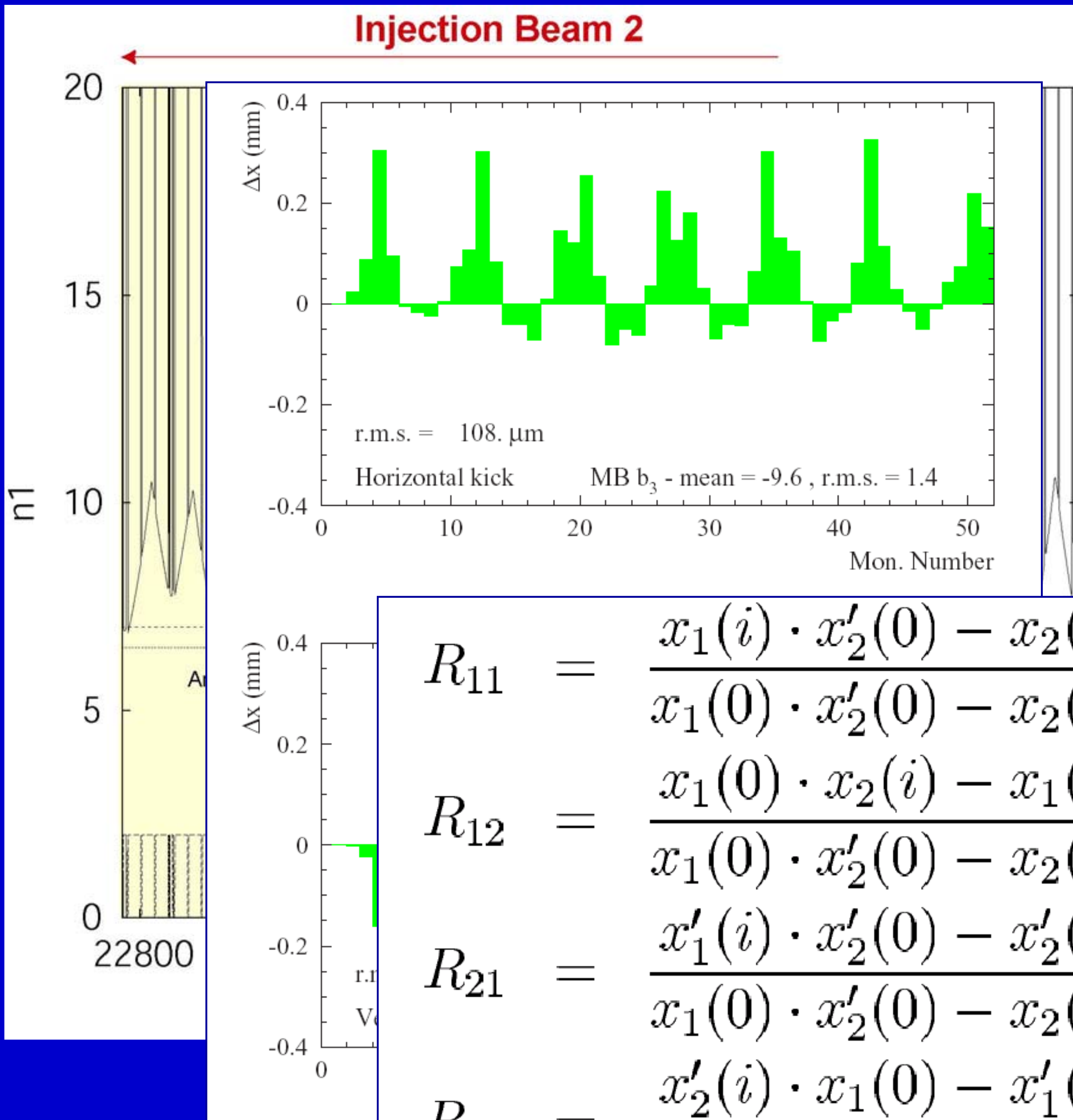


Motivation I

Check that it works, no problems with ongoing installation, things are as they should be

- Beam is the most powerful diagnostic tool in accelerators:
- Beam gives us the only 100% sure diagnostic that the aperture in the cold machine is free and has the expected size: Arc, IR8, crossing angle.
- Beam witnesses all electro-magnetic fields in the vacuum pipe and tells us about them: *polarity of design fields, field errors to 1 unit, large offsets between beam and magnet, corrector cabling.*

Checks with beam



$$R_{11} = \frac{x_1(i)\cdot x_2'(0) - x_2(i)\cdot x_1'(0)}{x_1(0)\cdot x_2'(0) - x_2(0)\cdot x_1'(0)}$$

$$R_{12} = \frac{x_1(0)\cdot x_2(i) - x_1(i)\cdot x_2(0)}{x_1(0)\cdot x_2'(0) - x_2(0)\cdot x_1'(0)}$$

$$R_{21} = \frac{x_1'(i)\cdot x_2'(0) - x_2'(i)\cdot x_1'(0)}{x_1(0)\cdot x_2'(0) - x_2(0)\cdot x_1'(0)}$$

$$R_{22} = \frac{x_2'(i)\cdot x_1(0) - x_1'(i)\cdot x_2(0)}{x_1(0)\cdot x_2'(0) - x_2(0)\cdot x_1'(0)}$$

Check the aperture

Get a handle on b3 etc. and corrector polarities

Linear Optics checks. Handle on quad & BPM errors

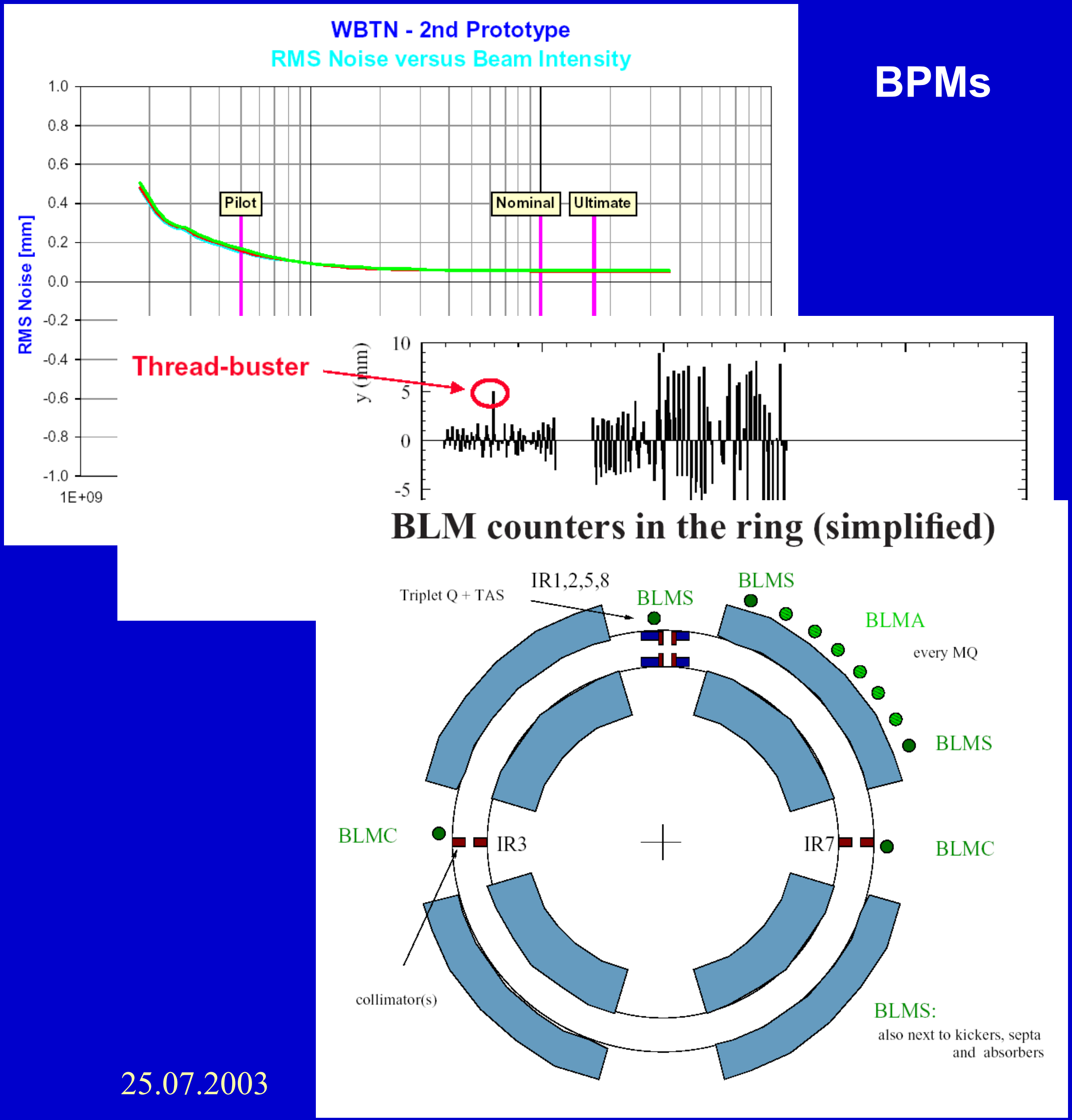
See Ralph's talk at Chamonix

Motivation II

Pre-commission essential acquisition and correction procedures

- Beam provides the only way to verify the proper functioning of the diagnostics *timing, BPM resolution, BPM cabling, BPM offsets, BLM resolution*
- Beam tests our control and correction systems (correctors, cabling, control system, software, procedures, …): *Bumps, trajectory correction, kicker timing, injection stability, beam threading*
- Hardware exposure to beam will allow first reality checks of assumptions: *quench limits, BLM thresholds*

Acquisition and Correction



BPMs

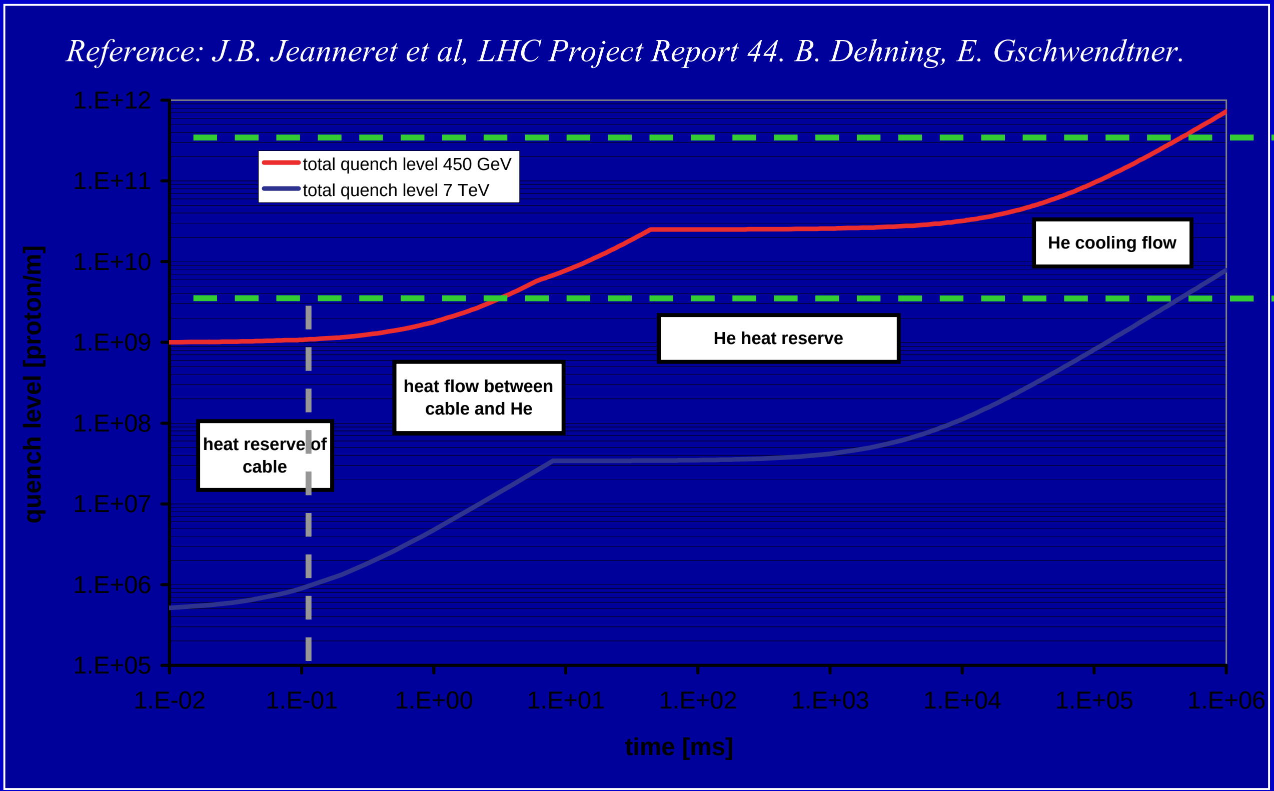
Threading

Beam Loss Monitors

Resolution: 0.05×10^9 p

And the control system has to work.

Check the quench limit



Damage level (few turns)

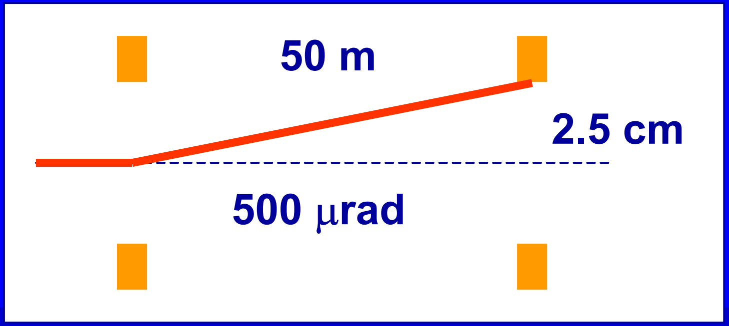
Pilot intensity

Pilot with 5 × 10^9 p does not quench if losses are diluted over ~ 5 m.

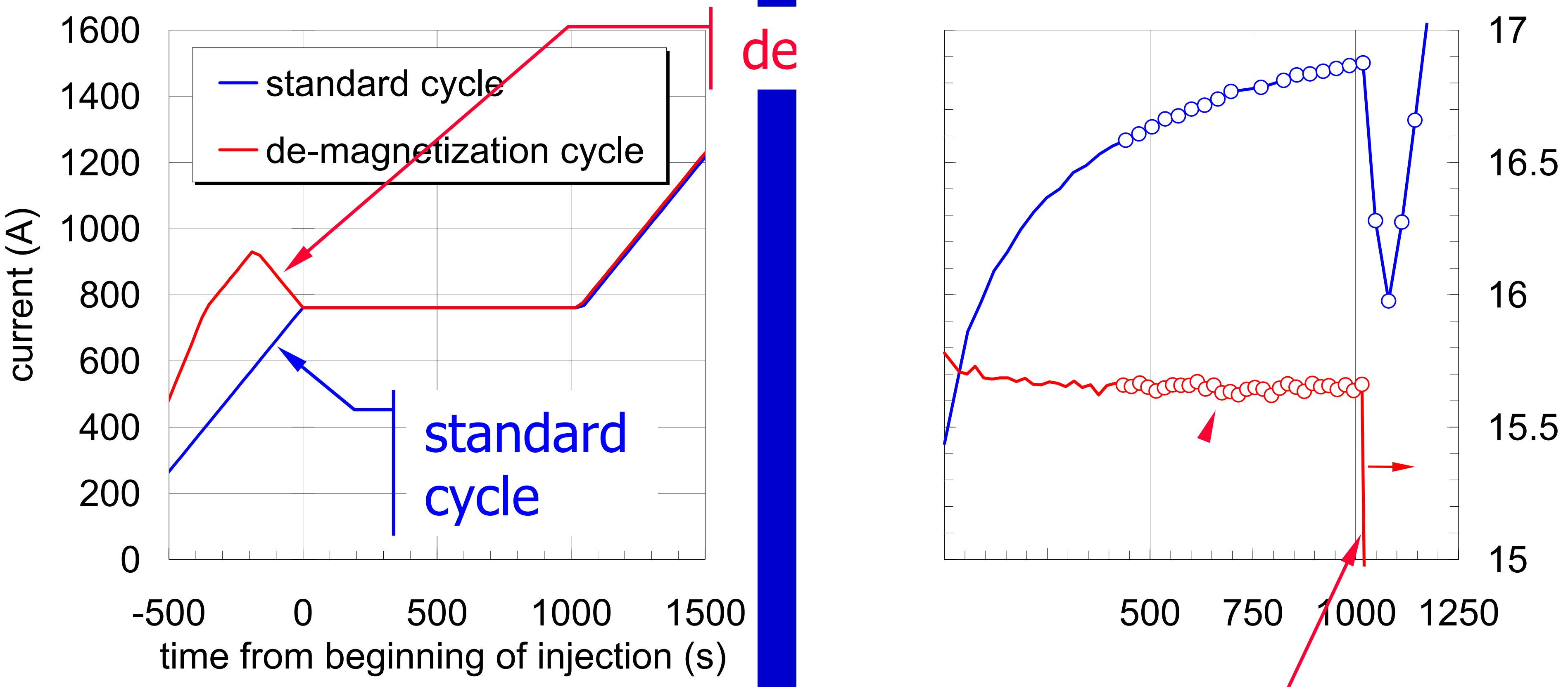
Uncritical studies – no danger for equipment.

Idea: Deflect beam into a magnet.
π bump over 100 m or single kick.

Measure: Quench threshold.
BLM rate versus kick or bump amplitude.



De-magnetization cycle



negligible decay after degaussing…

… but useless for operation (*giant* SB)!

How about injection tests ?

Motivation III

- Integration: full-blown system wide integration test.

  - One step beyond hardware commissioning.
  - Field test beam related equipment and instrumentation such as: power converters, kickers, septa, dumps, pickups, synchronisation, timing, injectors and get them all working together
  - Stress test controls infrastructure and all that goes with it.
  - Fully validate integration

  - Highlight oversights, debug problems. There will be problems.

Motivation IV

- **BIG MILESTONE:**
  - Beam instrumentation,
  - Controls
  - Interlocks
  - Access
  - Radiation Protection
  - Operations
  - And others…

  - These are absolutely critical for the effective exploitation of the machine and it cannot be stressed enough how important it is that they are ready and tested when we come to commission the whole machine.

Motivation

Commissioning of the first sector will have to be done. We will have to wrestle with the problems that will be encountered during this phase.

Discovering the problems during a sector test will give us a year at least to resolve any problems, perform a critically analysis of the performance of the systems involved and implement improvements.

Operationally, any time spent in 2006 on an injection test will be paid back during the first year's commissioning, enabling us to deliver physics faster.

De-motivation

- Too late to change anything
- Going to be busy enough anyway
- Cost
- Things will change, going to have to re-do it anyway…
- What do you do if you can’t get beam around after 2 weeks?

Test outline

	Test	Duration [hours]	Intensity	Number of shots	Integrated Intensity	Comments
1	Injection Steering, commission screens, IBMS, timing	12	5.00E+09	144	7.20E+11	TDI in, protecting LHCb
2	Trajectory acquistion commissioning, trajectory correction, threading	24	5.00E+09	288	1.44E+12	To beam dump
3	Linear Optics from kick/trajectory, coupling, BPM polarity checks, corrector polarity checks	24	1.00E+10	288	2.88E+12	
4	Aperture limits, acceptance	12	5.00E+09	360	1.80E+12	Pi bumps, BLMs, BCT
5	Momentum aperture	6	5.00E+09	60	3.00E+11	Move energy of SPS beam
6	IR bumps, aperture	6	5.00E+09	60	3.00E+11	Careful in LHCb
7	Commission normal cycle	12	5.00E+09	100	5.00E+11	
8	Energy offset versus time on FB	12	5.00E+09	100	5.00E+11	Cycle & repeat
9	Study field errors	12	1.00E+10	72	7.20E+11	Collect data, off-line analysis
10	Effects of magnetic cycle, variations during decay, reproducibility	24	5.00E+09	360	1.80E+12	12 cycles
11	Calibrate BLMs	24	5.00E+09	720	3.60E+12	couple with below
12	Multi-bunch injection - determination of quench level	12	3.6E+11	10	3.60E+12	start with pilot and work slowly up… localise loss appropriately
13	Effects of thermal cyclin					Long time scale - low priority
14	Squeeze at 450 GeV					…on triplet errors? Coupling?
	TOTAL	180		2562	1.82E+13	
	DAYS	**7.5**				

Coupled with high operational inefficiencies

Beam

- Pilot Beam for the most part:
  - Single bunch
  - Intensity: 5 to 10 x 10^9 protons per bunch
    - Below quench limit if losses are diluted over > 5 m.
    - 2 orders of magnitude below damage threshold.
  - Clear aim to minimise losses and use beam sparingly when we know where it's going.

- Total intensity: 2 x 10^{13} protons

Impact

We will need:

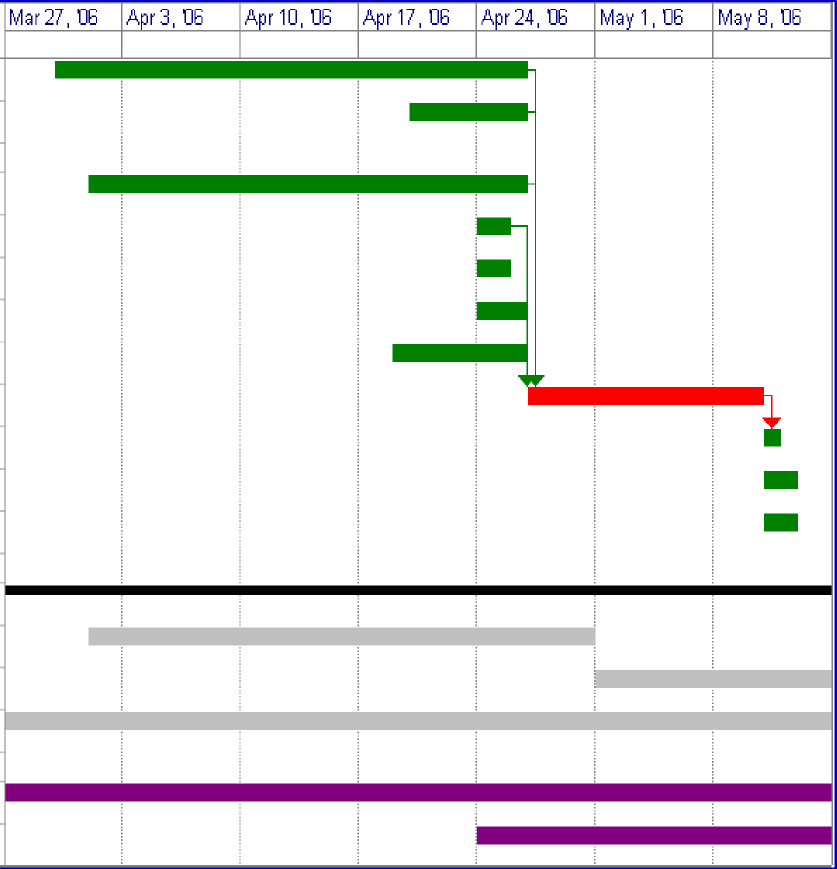
- **Sector 7-8 fully commissioned and cold**
- **Inner triplet, stand alone magnets right of IP8 cold,**
- **Injection region fully commissioned**
- **TI 8 operational**
- **Access system operational**
- **Appropriate radiation protection measures**

Impact

- On-going installation of 3-4, 5-6, 6-7
  - before, during and after the test.
  - disruption of installation in sector 6-7
- Hardware commissioning 4-5
  - Test will pull in resources from the above in preparation for the test and during the test itself
- Force the installation schedule of some systems
  - e.g. access and interlocks
- Consequences for installation and commissioning LHCb
- Radiation after the event: 7-8 potentially to be declared simple controlled radiation area with some knock-on effects
- Resources

Impact

ID		Task Name	Duration	Start	Finish
3		Hardware re-commissioning 7-8	28 days	Thu Mar 30	Wed Apr 26
4		Cold checkout, system tests	7 days	Thu Apr 20	Wed Apr 26
5					
6		SPS commissioning (after 2005)	26 days	Sat Apr 1	Wed Apr 26
7		TI8 re-commissioning	2 days	Mon Apr 24	Tue Apr 25
8		Install beam dump and shielding	2 days	Mon Apr 24	Tue Apr 25
9		Install Access Gates in tunnel	3 days	Mon Apr 24	Wed Apr 26
10		Commission access system	8 days	Wed Apr 19	Wed Apr 26
11		Test with beam	14 days	Thu Apr 27	Wed May 10
12		Radiation Survey	1 day	Thu May 11	Thu May 11
13		Remove Gates	2 days	Thu May 11	Fri May 12
14		Remove Dump	2 days	Thu May 11	Fri May 12
15					
16		Installation 6-7	180 days	Wed Feb 1	Fri Sep 15
17		Magnet transport 2-3-4-5-6	30 days	Sat Apr 1	Sun Apr 30
18		Magnet transport 2-1-8-7	15 days	Mon May 1	Mon May 15
19		Interconnection works	180 days	Wed Feb 1	Fri Sep 15
20					
21		Hardware commissioning 4-5	90 days	Mon Feb 20	Wed May 31
22		Hardware commissioning 3-4	84 days	Mon Apr 24	Mon Aug 7



Address the cost of this lot later

LHCb

- It has to be ensured that the experimental cavern at point 8 will be treated as a surveyed area after the injection test and not as a controlled area.
- This it has to be ensured that no part of the beam pipe or nearby detector will receive a radiation dose that would leave either activated after the test.
- Final vacuum chamber in place
- VELO only partially installed, not baked out, shouldn't be a problem

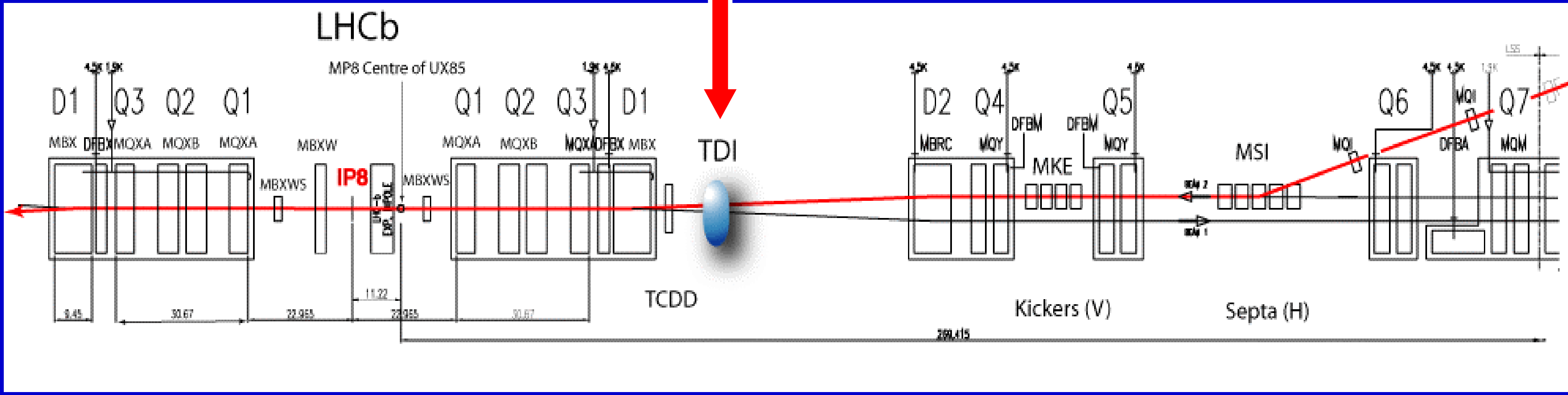
"The experiments are in favour of the test, provided that adequate precautions are taken to ensure that the continued installation of LHCb, after the test, is not disturbed in any way."

LHCb

Reasonable aperture
≈ 50 mm ≈ 18σ

No crossing angle

TDI: Can be closed as far as possible during injection optimisation



Detuned insertions

Smaller beam size

With care should be able to minimise losses.

Monitoring required.

Radiation

- ~ 3000 shots giving a totally intensity of 2 x 10^{13} protons
- Following simulations by RP group: typical dose rates for 1 day irradiation and 1 day cooling (at 50% efficiency):
- TED
  - Along side TED: 6 μSv/h
  - Downstream face of TED: 140 μSv/h
  - Would have a extra beam stop after the TED
  - Some irradiation of concrete walls around TED
- ARC
  - Assume beam is lost uniformly along the sector between point 8 and point 7: negligible
  - Assume beam is lost in one dipole repeatedly: 4 and 10 μSv/h
- This figures would be diluted even further by the extended cooling period

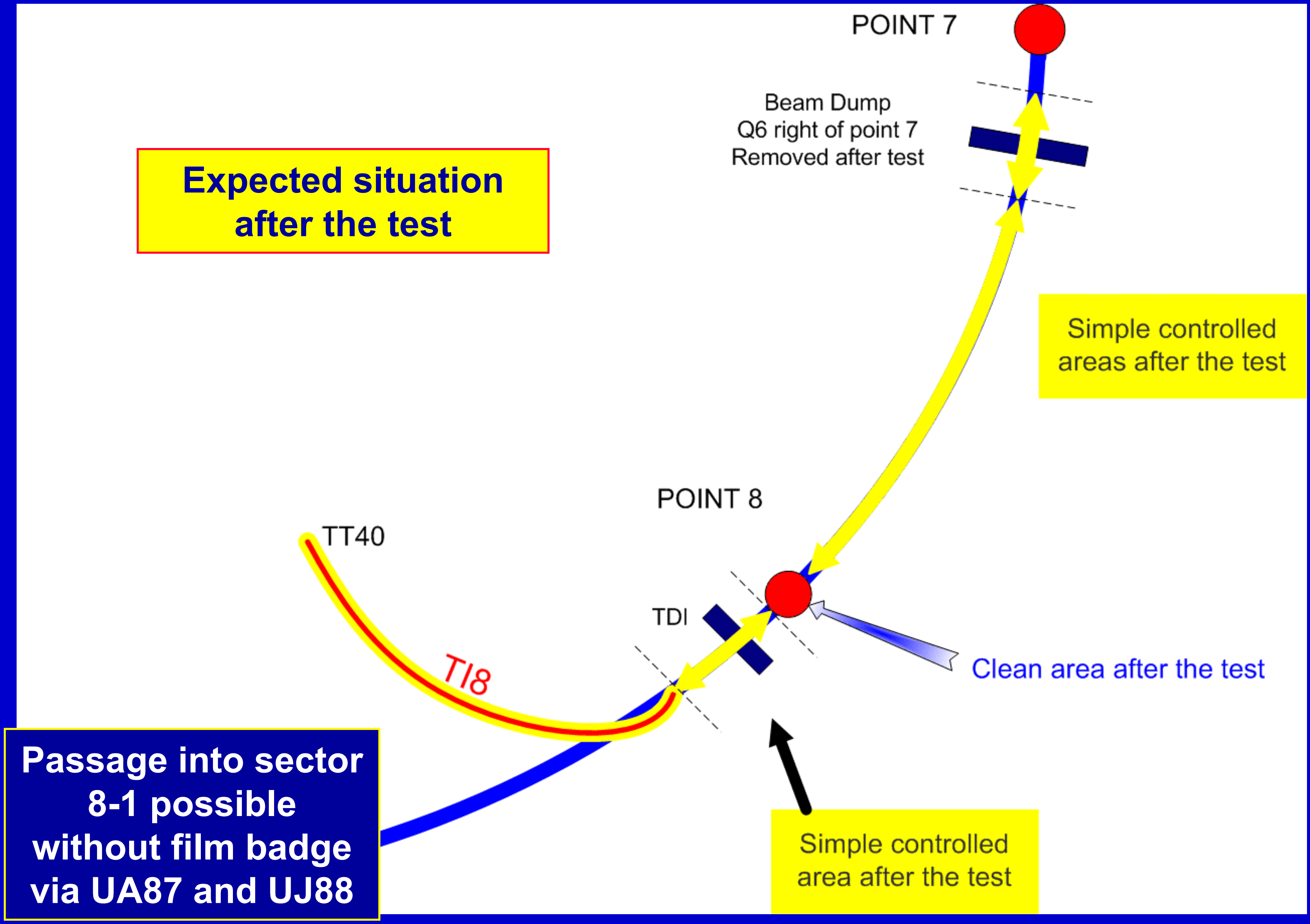
Radiation cont.

- Low level of activation
- For prudence we say we are assuming restrictions appropriate to simple controlled area.
- Dump can be removed within a day of test end, concrete in area will have some activation.
- It will be anticipated that:
  - TI8
  - the injection region
  - the arc
  - and the area around the the dump

  will be "Simple Controlled Areas" after the test. This means film badges.

- If the RP survey after the test finds negligible activation the Simple Controlled Areas can be reclassified as "Surveyed Areas"

Radiation


POINT 7
Beam Dump
Q6 right of point 7
Removed after test
Expected situation
after the test
Simple controlled
areas after the test
POINT 8
TT40
TDI
TI8
Clean area after the test
Passage into sector
8-1 possible
without film badge
via UA87 and UJ88
Simple controlled
area after the test

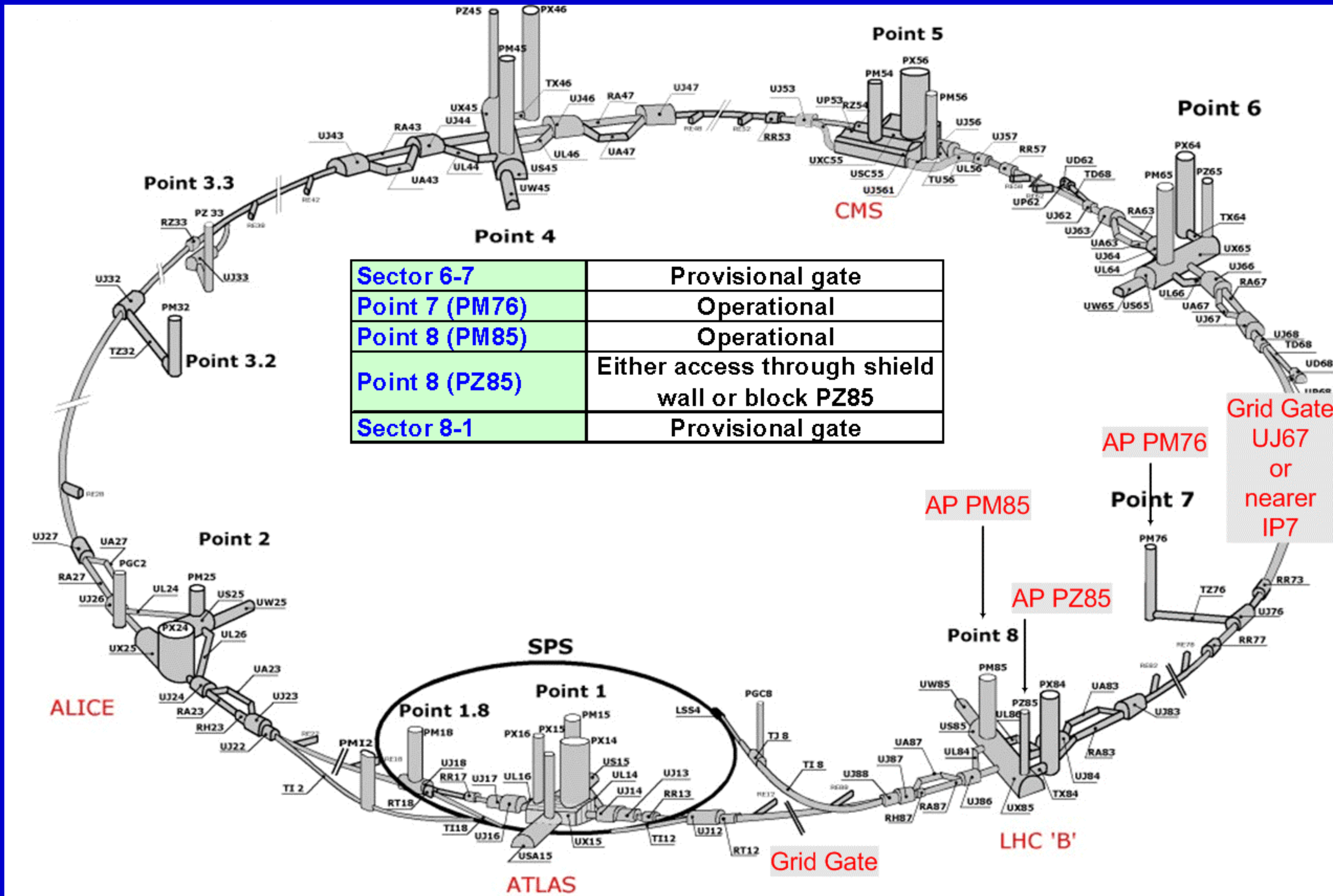
Monitoring

- **Radiation monitoring**
  - Radiation Monitors will be provided by TIS
  - RAMSES have injection test as milestone
  - LHCb: 4-5 planned under RAMSES not designed to measure zero. Extra monitors required, 2-3 PMI monitors, modern data monitoring.
- **Beam Loss Monitors**
  - Sensitive to losses at 1% level with pilot bunch intensity
- **Beam Intensities**
  - Beam extracted, injected and to dump to be logged
- **RPG survey after the event**

INB

- Tell them that we are going to perform the test
- Tell them estimated intensities, estimates of likely activation, and estimates of personnel dose.
- Propose, and then discuss with them possible approaches for appropriate restrictions
-
- Report to be presented in 2004 at the same time as the Dossier de Sûreté.

Access



Sector 6-7	Provisional gate
Point 7 (PM76)	Operational
Point 8 (PM85)	Operational
Point 8 (PZ85)	Either access through shield wall or block PZ85
Sector 8-1	Provisional gate

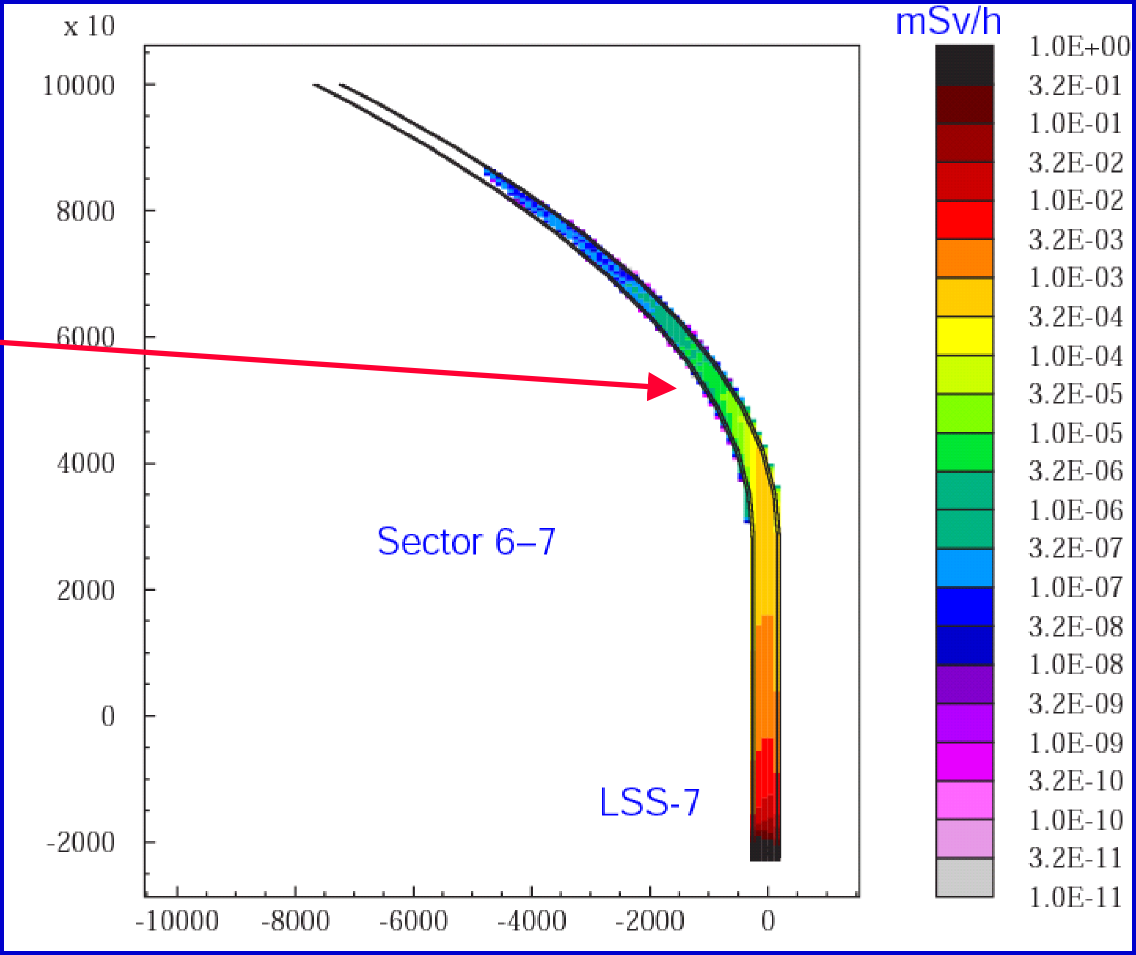
Enrico Cennini

UJ67 versus near IR7

- Contours of muon dose rates in sector 6-7. Distances in cm.
- Contours calculated for <u>pilot pulses only</u>
- 0.1 μSv/h is at 500 m. from the IP
- Several nominal bunches would be 100 times higher

From a RP perspective it is more convenient to put the gate close to IP6

However a sizable fraction of 6-7 could be opened up for continued installation during the test



Graham R. Stevenson

How much is this lot going to cost?

Cost AB

- **Target and Dumps**
  - TDI, TCDD already installed and commissioned
  - Dump right of point 7
    - Capital: reusable dump of some sort e.g TED, detailed installation planning effort required
    - Installation: 2 days, at least 3 experienced persons
    - Removal: 2 days, at least 3 experienced persons
    - Extra beam stop: straightforward
- **Beam Transfer**
  - Kickers, already installed and commissioned
    - Manpower costs: minimal
- **Controls**
  - Very favourable, would act as important milestones and test of final system. Clearly advanced effort required but no irrecoverable, additional costs.

Cost AB

- **BDI**
  - Test would be extremely welcome. Would clearly generate a lot of work: preparation, test, data analysis, presentation, but…
  - 6 BLMs per quadrupole foreseen. Optionally (NB) extra BLMs for quench test – smother quad/dipole. Would need to pull temporary fibres, install readout electronics. 1 fibre per 6 BLMs, say 180 BLMs, 30 fibres* 300 m ... around 50,000 CHF
  - Temporary installation of BCT near beam dump, if required. Would need to be asked for, BDI learn nothing. Hardware reusable.
    - 20 -30 kCHF for manpower
  - Temporary installation of screen near beam dump. Again manpower. Hardware reusable.
    - 20 -30 kCHF for manpower

Hermann & Rhodri

Cost AB

- **Power Converters**
  - Test will generate more work for the PO group. Manpower cost and it's especially the availability of the specialists.
  - The problem of injection test is the re-commissioning of the sector 7-8 and insertion in 8-1 in parallel with the commissioning of two other sectors (3-4 and 4-5).
    - Could we postpone the commissioning of the sector 3-4 ?
  - Good milestone for the project but a big perturbation. Manpower not planned for in the staffing plan.
    - It's a pity not to have it at the end of the sector 7-8 commissioning…
  - No big extra cost for materials
  - The main gain for PO group would be to check the reproducibility of the current with beam.

Freddy Bordry

Cost AB

- **Operations**
  - 2 weeks+ out of SPS physics schedule for 2006, would delay CNGS
  - Running costs of SPS
    - Power consumption (40 MW*168*30 CHF/MWh) ~ 400 kCHF
    - Might argue that this comes out of normal exploitation budget.
  - TI8:
    - preparation and re-commissioning (couple of days)
    - power consumption (36MW*50%*168*30 CHF/MWh) ~ 100 kCHF
  - Start SPS before April?
    - CERN can request to switch to the French EDF grid as of the 15/3. Between the 15/3 and the 1/4 critical days occur frequently.
  - No impact on magnet tests.
- **RF**
  - Fast timing references, pre-pulses etc. Cost minimal.
- **ABP**
  - Favourable, lot to learn…

Cost: Installation

- **Installation**
  - **Sector 6-7 scheduled for:**
    - **Cryo-magnet transport to 6-7**
    - **Interconnection work**
    - **Warm MQ, D3, D4 & Q6 in LSS.7L**
  - **With precise dates, staying to schedule and 6 months advanced notice: No additional cost. 6-7 installation delayed by 2 weeks.**
  - **Do not compromise free access through the sector after the test…**

Therein lies a potentially expensive problem…

Sylvain Weisz & Jean-Philippe Tock

Contractors

The installation will be performed in the LHC main tunnel and its annexes. These zones are classified as non-radiation controlled areas and consequently no special radiation protection requirements are asked from the company.

After the test a part of the LHC tunnel might have to be classified as simple controlled radiation area. In this case the work site conditions might change.

The workers to intervene there have to be belong to the category of Radiation Workers. In the Legislation of most CERN members states, personnel would be classified as "Category B Radiation Workers" according to the European Council Directive 96/29 Euratom. (class B < 6 mSv/y)

= MORE MONEY

≈ 1 to 1.5 kCHF per person

Cost: Installation

- **Problem: Contractors that have to pass through the tunnel have to be classified for work in radiation areas.**
  - **How many people implicated?**
  - **Transport of magnets, 20 people maximum (at any one time) - maximum 5 magnets a night, average 3**
  - **Interconnections: would be finished in 8-1 and 7-8, so passage of personnel and materials via other IPs. Do they need to come through these sectors? Apparently not. (40 people if they do)**
  - **Transport of material: point 6 could be used (but access facilities not identical to point 8)**
  - **Work in controlled zone after the test:**
    - **Electricians – no maintenance foreseen, very limited access required.**
    - **Cabling: work in sector 8-1 & 7-8 after test – should be minimal**
    - **Maintenance: vacuum, cryogenics, power converters…**
    - **Cleaners**
  - **Warm magnet installation right of 7 after test**
    - **It will be a Simple Controlled Area, film badges will be required to work there. (Cabling, infrastructure etc.)**

Estimate around 100 people

Cost AT: Vacuum

- Temporary dump installation right IP7
  - Planning/instrumentation and mechanical design work: 2 weeks design work
  - Capital cost: 4*7.3 m standard vacuum chamber: 12 kCHF (chamber reusable)
  - Preparation and installation manpower: 2 – 3 man weeks
  - Q6 preferably installed before test.
- Warm elements right IP8
  - Should be installed, and commissioned already.
  - NEG not activated, mobile pumping if required.
  - MKI need to be fully baked out
  - Beam instrumentation must be ready on time.
- NB Late elements face a surcharge…

Paul Cruickshank

Cost AT: Cryogenics

- Sectors will be left floating i.e. normally around 55 to 75 K, but up to 300 K if there are problems. Standard cryogenic operations should be able to perform the cool down in about 3-4 days from floating; up to 14 days from higher temperatures.
- Team sized to work on one sector at a time and would have to stop work on the ongoing commissioning of other sectors while re-commissioning 7-8

One Month	SECTOR [kCHF]
ELECTRICAL POWER	122
HELIUM	20
LIQUID NITROGEN	206
OPERATORS	53
MAINTENANCE	21
TOTAL	422

Total will be reduced by a factor of 2 if the sector has not warmed up and the test is not done in parallel with another cold sector

NB: need Q5.R8→IP8 as well

Hardware re-commissioning

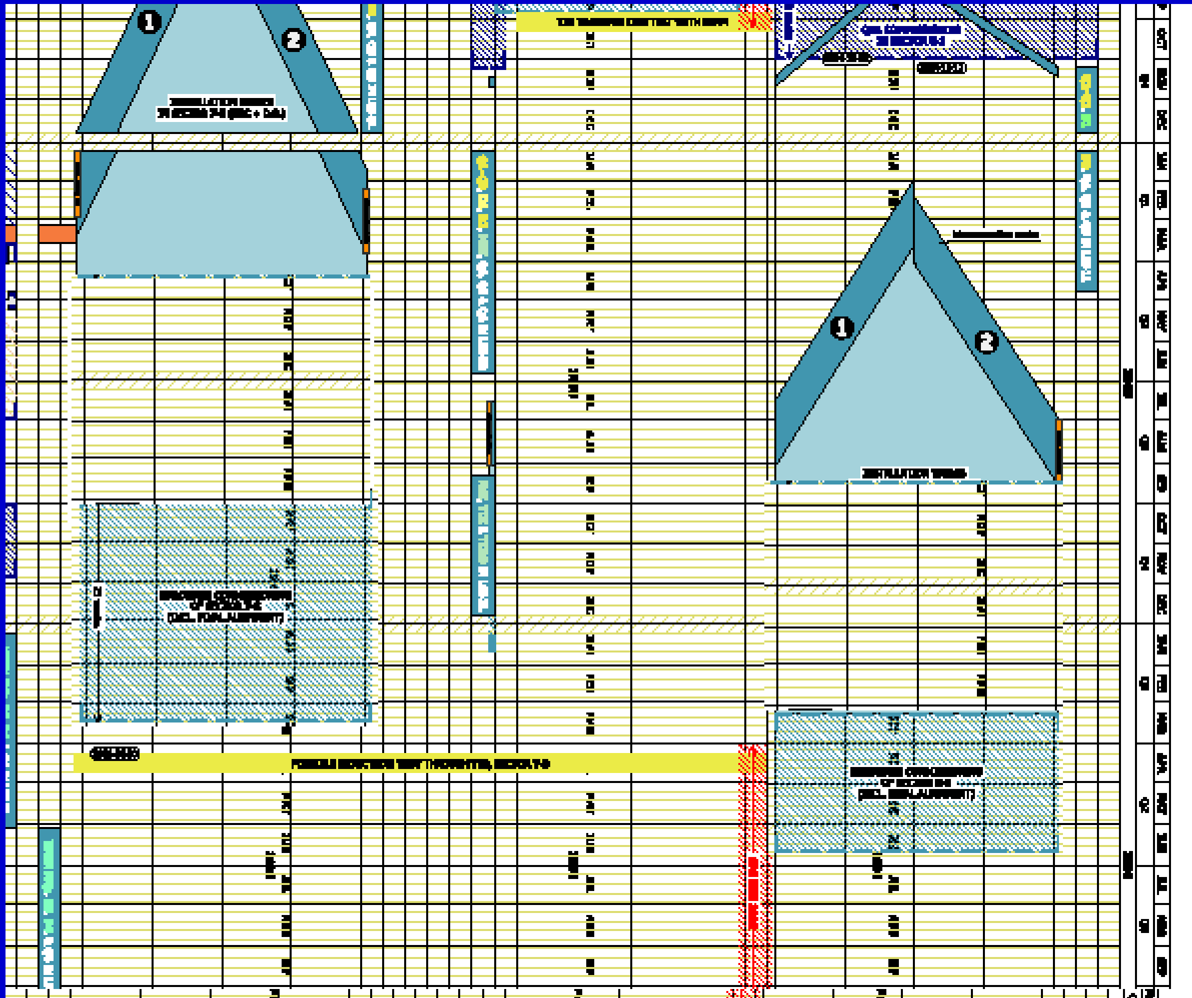
- Vacuum
  - Continued on-line monitoring of status after commissioning – things should be OK
- Cryogenics
  - $\rightarrow$ (Operators in total) + Engineers/Technical engineers effort from commissioning elsewhere
- QPS and Energy Extraction (AT/MEL)
  - 1 week for system tests, 1 week for cross-system checks. 3 to 4 people fulltime
- Interlocks
- Powering: see Freddy's comments
- Cross system tests
- Plus HW supervision/on-call during test

TOTAL MANPOWER ≈ 10 MAN MONTHS plus a 2-3 week delay

Test after HWC 7-8…

The case for having the test immediately after the commissioning of sector 7-8

- Avoid the need for re-commissioning 7-8
- Avoid splitting teams across more than two sectors
- Avoid cost of re-cool down



Plus possible delay in installation of inner triplets beam screens & Q6.R7

Roberto Saban

25.07.2003

Cost ST: Access

- **Access**
  - PM76, PM85 as for LHC
  - PZ85: infrastructure as for LHC
  - Access Gates: installation and removal of gates in 6-7 and 8-1 (in foreseen positions)
    - 7 kCHF manpower
  - Specially installed gate for the test in 6-7 (Gate plus lock, cabling, junction box, display etc.)
    - 20 kCHF + 5 kCHF for long distance cabling.
  - Interlock chain – loops should be in place
- **Commissioning of system seen as useful milestone**

Pierre Ninin

Cost TIS: RP

- Simulations of potential doses, preparation of report for INB
  - 5 man months (4 months down already!)
- Radiation Survey, installation, data handling etc.
  - 1 technician hired earlier than planned 90 kCHF
- Additional monitors in LHCb & 6-7
  - 40 – 50 kCHF

Graham Stevenson, Doris Forkel-Wirth

Cost summary AB

			ATTRIBUTABLE COSTS			
			CAPITAL	MANPOWER	Comments	
AT/MEL	Septa	Tests	nil	available	Already installed	
AB/BT	Kickers	Tests	negligible	available	Already installed	Endorsed
AB/ATB	TCDD		nil	available	Already installed	Supportive
	TDI		nil	available	Already installed	
	Dump point 7	Installation and removal	Incidental	4*3 man days	Planning required	
	Shielding point 7	Installation and removal	Minimal	2 man days		
AB/PO	Re-commissioning	See HWC		Extra work...		Endorsed with reservation
AB/BDI	BLMs	Additional BLMS/cables/racks	50 kCHF	20-30 kCHF	Optional	Strongly endorsed.
	BCT near dump	Installation	Incidental	20-30 kCHF	HW reusable	
	Screen near dump	Installation	Incidental	20-30 kCHF	HW reusable	
AB/OP	2 weeks SPS	80 MW on LHC cycle*50%	400 kCHF	pro rata		Strongly endorsed.
	2 weeks TI8	32 MW peak * 50%	100 kCHF			
	Delay to CNGS					
AB/CO	Controls	Control room	nil	nil	On the schedule	Strongly endorsed.
		Infrastructure	nil	nil	On the schedule	
		Applications	nil	nil	On the schedule	
		Interlocks - power	nil	nil	In place for HWC	
		Interlocks - beam	nil	nil	On the schedule	
TOTAL AB			500 kCHF	80 kCHF +		STRONGLY ENDORSED

Cost summary – not AB

Access	AP PM76	On the schedule	nil	nil	Needed anyway	Useful milestone
	AP PM85	On the schedule	nil	nil	Needed anyway	
	AP PZ85		nil	nil	Needed anyway	
	Gate sector 1-8 & UJ67			7 kCHF		
	Gate arc 6-7		25 kCHF	3 kCHF		
	Interlock backbone	On the schedule	nil	nil	Needed anyway	
TOTAL ACCESS			25 kCHF	7 kCHF		
Radiation	RAMSES		nil	nil	Test already milestone	Supportive
	+ Radiation Monitors		50 kCHF			
	Simulation			1 man month	4 months already attributable	
	Survey etc			90 kCHF	Technician taken on early	
TOTAL RP			50 kCHF	100 kCHF		
HWC	Vacuum			minimal		Supportive
	Cryogenics					
	QPS/Energy Extraction			3-4 * 2 man weeks		Supportive
	Powering			Difficult with present schedule		
	Interlocks					
	Cross-system checks					
TOTAL HWC				10 man months	2-3 weeks delay	
Installation 6-7	Transport disruption	Can swallow 2 weeks				Wary
	Interconnect disruption					
	Radiation classification			50 - 75 kCHF	assume 50 workers	
TOTAL INSTALLATION				50 - 75 kCHF		
Cryogenics	Cooldown (max)	Electrical Power	122			Nothing to learn
	Manpower - see HWC	Helium	20			
		Liquid Nitrogen	206			
		Operators	53			
		Maintenance	21			
	200 - 400 kCHF	MAX TOTAL	422		Depending..	
TOTAL CRYO			~300 kCHF			
Vacuum	Planning point 7		nil	2 man weeks		Supportive
	Installation point 7		15 kCHF	2-3 man weeks	Capital cost recoverable	
TOTAL VACUUM			15 kCHF	10 kCHF		

Warily Supportive

TOTALS – highlights

	CAPITAL	MANPOWER
AB	50 kCHF (optional) plus incidentals	80 kCHF plus workload
SPS – power	400 kCHF (energy budget?)	-
TI8 - power	100 kCHF	-
TIS/RP	30 – 50 kCHF	100 kCHF
Access	25 kCHF	7 kCHF
Vacuum	30 kCHF (recoup)	10 kCHF
Cryogenics	200 - 400 kCHF	Included in capital total + HWC
Installation	-	100 KCHF (radiation qualified personnel).
Hardware commissioning	-	10 man months + delay
TOTAL	~1 MCHF	380 kCHF

All numbers approximate – planning as it stands

Timing of test

- PS and SPS will be starting up after 2005 shutdown
  - SPS under energy consumption restrictions before April 1st.
  - Estimate 4 weeks for cold checkout & re-commissioning
- Injection test pushed to end April unless provision is made to start SPS earlier.
- For LHCb, April 2006 is the most convenient time slot for the injection test.
  - Taken in account in their planning
  - A delay of the sector test by more than 10 weeks beyond April 2006 would jeopardize the LHCb overall commissioning.
  - The interruption to the LHCb installation due to the injection test should not exceed three weeks.

→ 2 weeks at end April/May 2006

Conclusions

- 2 weeks low intensity beam, end April/May 2006
- Motivation
  - Check
  - Commission
  - Integration
  - Milestone
  - Politics

→ The test could go a long way to easing the commissioning of the whole machine.

- The intensities we plan to use are low, with care there should be only a low level of activation.
  - Assume restrictions appropriate to simple controlled area where required
- Very careful putting beam through LHCb, with appropriate monitoring we can ensure it remains a surveyed area.

Conclusions

- Planning of HWC needs to fully incorporate test:
  - Manpower/Capital costs
  - Could save ~0.5 MCHF by having test follow 7-8 HWC and suitable placement of 8-1 HWC
- With appropriate planning costs to installation should be low.
- Main inconvenience will be the need to declare the parts of the ring Simple Controlled Areas with knock-on effects for access after the test.

- Experiments OK, AB enthusiastic, AT, ST & EST supportive with provisos. RP very supportive.

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